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THE PEARSON-READHEAD SURVEY FROM SPACE

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ABSTRACT

The VSOP Space VLBI mission uses the HALCA spacecraft, launched from Japan in February 1997, in conjunction with ground radio observatories around the world to create a high resolution radio-wavelength imaging facility. We are using this unique facility to observe a complete sample of Pearson-Readhead Survey sources (Pearson and Readhead 1988) at 4.8 GHz, to determine core brightness temperatures and pc-scale jet properties. In addition we are obtaining matched-resolution 15 GHz observations using the VLBA at epochs close in time to the space VLBI observations to investigate the spectral indices of these sources at high resolution.

INTRODUCTION

Ground-based VLBI imaging surveys have been of critical importance in determining the general morphological and dynamical properties of the nuclear regions of active galaxies (e.g., Pearson and Readhead 1988). Studies of individual sources alone leave many questions unanswered, and can even provide a biased view of nuclear activity. The statistical results obtained from imaging surveys have been key in providing constraints and insights for theoretical models of nuclear jets and environments. The same can be true for space-based VLBI imaging surveys.

The VSOP imaging survey we are undertaking is aimed at studying the nuclear regions of a complete sample of active galaxies. In addition to exploring the menagerie of source morphologies and dynamics, we will address a number of specific questions aimed ultimately at elucidating the fundamental characteristics of galactic nuclear activity and the physical conditions in these regions. Such questions include:

- What is the brightness temperature (T_b) distribution of the nuclei and the inner jet components? Is there a characteristic maximum T_b?
- What is the distribution of jet speeds in regions less than a parsec from the nucleus and how does it compare to the distribution at parsec scales? Are there signs of deceleration, acceleration, or collimation?

- What is the relationship of the jet directions in the sub-parsec nuclear region relative to those farther downstream? Is the result consistent with helical jet models?
- Is there any evidence for interactions with a denser ISM closer to the nucleus?
- How do jet components vary in strength as a function of distance from the nucleus?
- Is there any evidence of free-free absorption from an ionized torus near the nucleus (from dual frequency observations)?
- Are there some jets bright enough to allow transverse structure to be studied (e.g., edge brightening, opening angles)?
- How do the limits on Doppler factors obtained from T_b measurements compare to those obtained from proper motions? Are the results consistent with inverse Compton theory?

THE SAMPLE

The complete sample from which we have drawn our sources is the Pearson-Readhead sample which has been used for extensive ground-based VLBI survey studies. The Pearson-Readhead sample is defined by the following criteria: (1) $\delta > 35°$; (2) $|b| > 10°$; and total flux density at 5 GHz > 1.3 Jy (see earlier ref.). This sample is ideal for a VSOP survey because the sources are strong, the VSOP u-v coverages are especially good above $+35°$ declination, and multi-epoch ground-based VLBI data and other existing supporting data on these sources exceeds that of any other possible sample. Based on the multi-epoch ground-based VLBI observations at 5 GHz of this sample involving two of us (TJP and ACR), we have been able to carefully choose a complete subset of this sample that is most likely to show fringes on VSOP baselines.

RESULTS

To date we have imaged 10 of the 31 sources in the sample. In Figures 1 and 2 we show examples of these 4.8 GHz images for the sources 2200+42 (BL Lac) and 0923+392. For comparison, below each image we also show the image of the source that can be made with the same data set if the baselines to the HALCA spacecraft are removed, and only the VLBA data are used. Boxes superimposed on the ground-only images show the areas of the maps that are shown in the VSOP images. Note the significant increase in fine-scale detail that is apparent in the VSOP images compared to the ground VLBI images.

It is too early yet to make conclusions regarding the general questions posed above, which we defer to a later date when we have a larger number of reduced experiments available. For now we note that the VSOP mission is routinely providing high quality data at 5 GHz for the Pearson-Readhead survey in space, the data reduction and imaging in AIPS and DIFMAP are largely routine operations, and the final images are of high quality. The structural detail revealed in the space VLBI images is much higher than from the ground-based images at the same frequency.

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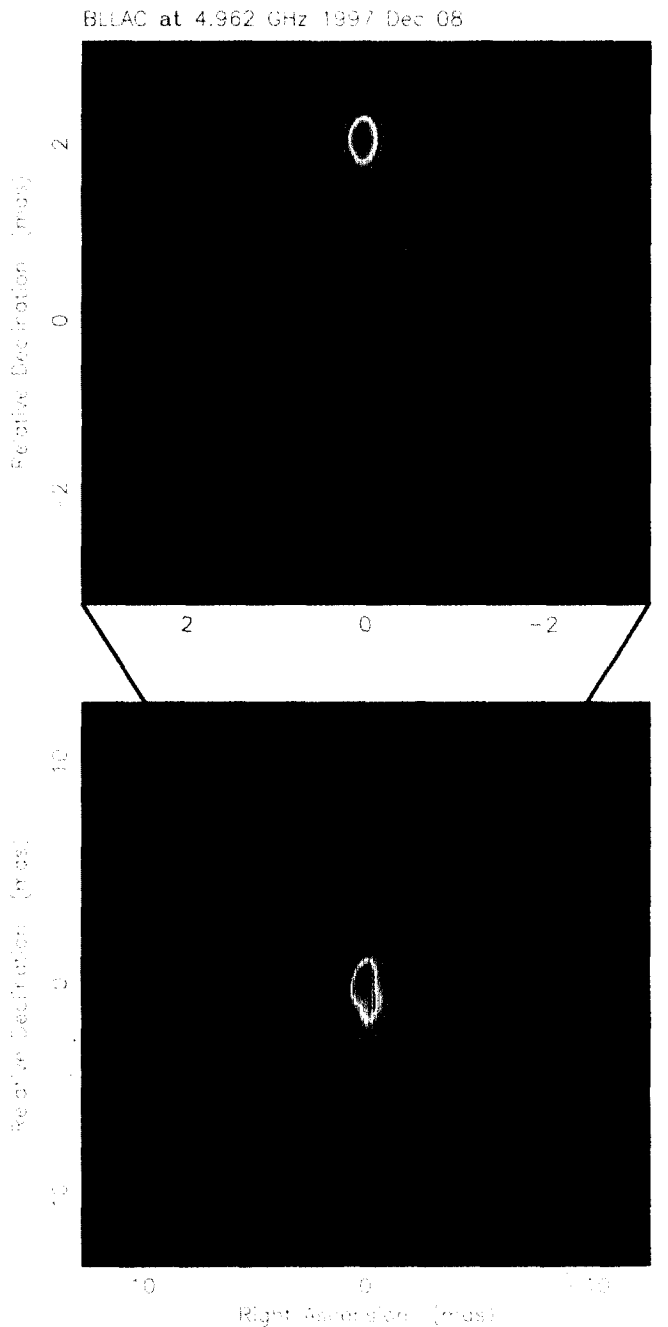

Fig. 1. *A comparison of VSOP space VLBI and ground VLBI images at 4.8 GHz for the source 2200+420 (BL LAC).*

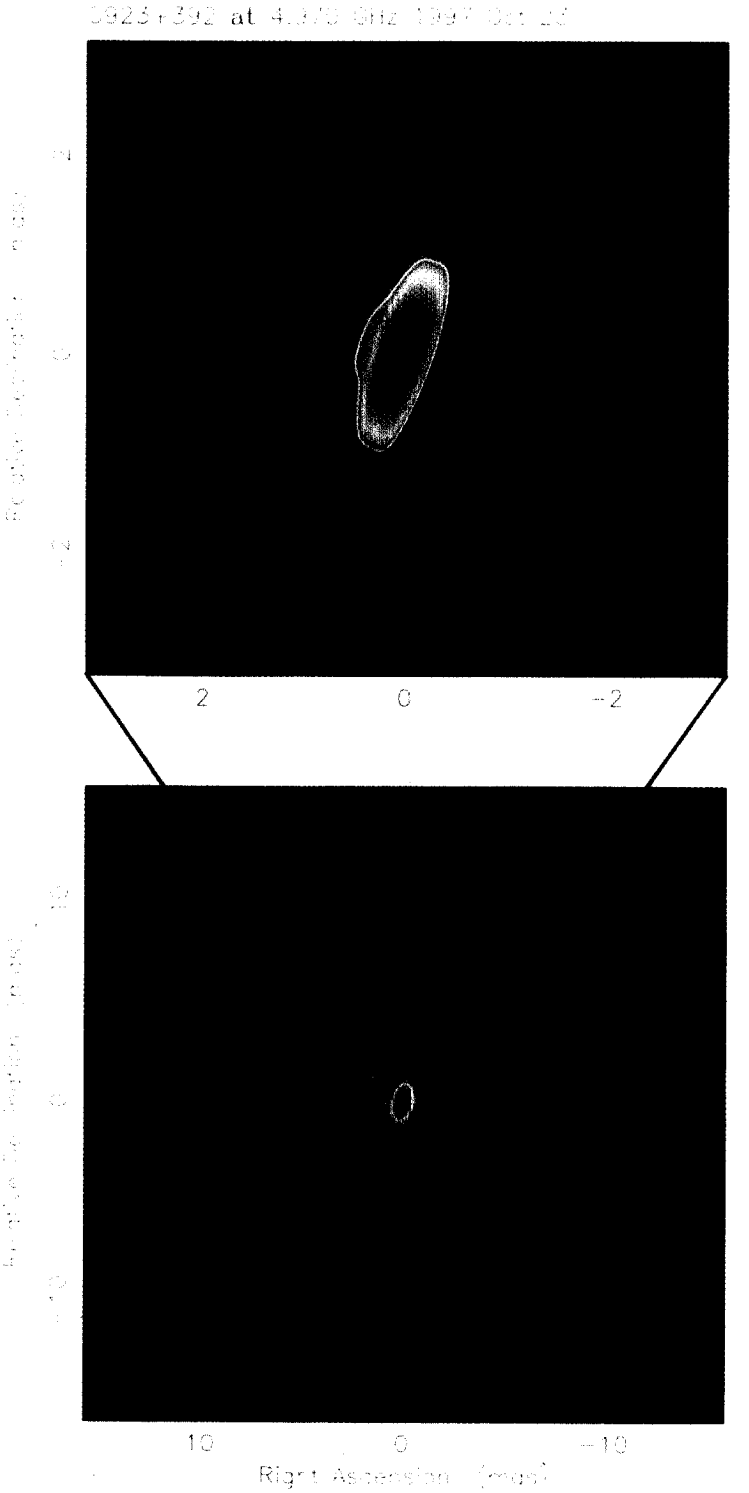

Fig. 2. *A comparison of VSOP space VLBI and ground VLBI images at 4.8 GHz for the source 0923+392.*